ON THE FUTURE OF WORK

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1. Preliminaries

Job scares have been a feature of our kind of market economy for at least two hundred years. Since the beginnings of the industrial revolution, every once in a while a general feeling sweeps the land that jobs are scarce, or ill-paid, or both; that work is in danger of disappearing. Some of these scares are associated with the cycle: since a capitalist economy goes up and down, employment rises and falls with output. Such cyclical scares are relatively benign –the Great Depression was an exception- and easily forgotten. Others, however, seem to result from the action of deeper, more powerful forces - invasions, plagues, great inventions - and are thought to leave permanent marks on the economic landscape: such crises can be called structural.

Work scares, like economic crises, are a complex phenomenon: partly real and partly imaginary. Real or imagined, but more so if real, they can leave great scars in a community, something easily understood once one remembers that work fulfils three basic human needs in our societies: the wish to develop our capabilities, the need to interact with others and the need to earn one's sustenance. How to see scares coming and how to limit their potential damage are, consequently, important practical questions. Not everyone approaches them in the same spirit, however: some, a small minority endowed by Nature with nerves of steel, tend to take the long view: all is well that ends well. Is it not true that there are many more jobs today than were available in the early 1820s? Is it not the case that GDP, both in absolute and in per capita terms, is an order of magnitude higher now than it was then? The majority will of course answer both questions in the affirmative; but some, looking more closely at things, will take into account the misery that afflicted so many people in the transition between happy states and wonder if there could be ways to mitigate such suffering the next time around. It is this view that inspires, as it should, most of the literature generated around the question of the future of work. Still others, imagining a happy new world in which machines free humans from drudgery, see no cause for worry; on the contrary, our descendants will find themselves occupied in noble pursuits. Disregarding both what may be called the

Utopian and the extreme long view, we shall take the majority approach in what follows[1].

One final note: the concern about jobs has three dimensions: number, wages and quality of work. Of these three, only the first two have been intensively studied. The last one tends to be disregarded, following the dichotomy work/leisure today in fashion: work is undertaken to provide better, more expensive leisure; that it may be unpleasant work is a secondary consideration. [2] In what follows, we shall follow the trend.

2. Why structural?

The concern about the future of work pre-dates the current crisis –"the most recent" in the US- but has been aggravated by it. The belief that questions about the future of work will not go away with an improvement in business conditions is grounded in three observations: first (jobless recoveries), that for the first time in recent history, employment has lagged behind output, while in the past both tended to rise and fall in unison; second, that the share of labour in GDP has fallen steadily for the last thirty years (not only in the US) as wages have stagnated; third (polarisation), that the fall in wages and employment has not been uniform across the scale of skills; it has affected mostly those in the middle of the scale, clerical and administrative jobs and simple manufacturing jobs. Such developments have been attributed to a combination of skill-biased technical progress (leading to a wage premium for those with a college education), globalization (offsetting the relative scarcity of unskilled labour in advanced economies) and digitalization (replacing men by computers and robots). These forces are believed to be permanent, and this is what makes the current scare look more serious than, say, the fall in employment that followed the oil crises in the seventies or the end of the dot.com bubble in the nineties. In what follows we shall concentrate on the last of these forces, digitalization. The mainstream position on digitalization can be summarized in three points: first, that technological

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The study by CASE and DEATON quoted at the end provides evidence on the effect of long-term (enforced) leisure on morbidity and mortality.

[2][2] On the quality of work, see The two books by Simon HEAD quoted at the end. A spirited defense of the need to work may be found in Dorothy L. SAYERS, 'Why Work?' (1942)

change will not only stay with us, but accelerate, while institutions lag behind; second, that business as usual will not solve the problem of work disappearance; third, that both economy and society must re-invent themselves to keep up with accelerating technology.[3] Notice here that technology is taken here as an exogenous, blind force, a point to which we shall return at the end of this note.

We shall start with an exposition of the mainstream view of the issues, to be contrasted with another, less conventional, but in my view both more accurate and more useful.

3. Robots (and computers) are eating men!

'Sheep are eating men!' complained the Cardinal in Sir Thomas More *Utopia* (1516), as landlords proceeded to enclose common lands to grow sheep, an activity that required much less labour than farming. The complaint has taken new life with digitalization: we fear that robots in manufacturing and computers in services may make people redundant in large numbers. This concern has generated research based on an implicit assumption: wherever machine can replace man, it will. More on that assumption later.

LEVY and MURNANE (2004) ask the question: What task does a machine do better than a man, a man better than a machine? Dividing tasks into manual (M) vs. cognitive (C), routine (R) vs. non-routine (N) they construct a 2x2 matrix

CR Clerical, administrative	CN Scientific, creative, executive
MR Packaging, assembly line	MN Truck driving (so far), home cleaning

Their main result is that routine activities, both manual (filling boxes of cereal) and cognitive (checking personnel records) are at risk, since they can be quickly and cheaply digitalized. Non-routine jobs, on the other hand, are more sheltered: the manual jobs (gardening, placing products on supermarket shelves) because automating them is either very difficult or too expensive with the current state of technology; the cognitive ones,

[3] S. The Hamilton Project(2015).For globalization, s. BLINDER (2009).

because they make use of abilities such as creativity or social skills.

LEVY and MURNANE's approach has been refined in several directions. FREY and OSBORNE (2013) is one of the most often quoted papers in the field. The authors start from a slightly different angle: what engineering obstacles hinder the replacement of man by machine in specific occupations? Using a very detailed classification of occupations available only for the US, the O*NET, comprising over 900 different items, they arrive at a ranking of occupations according to the probability of their being replaced by computers. The main result: 47% of 400M US jobs are considered "at high risk", 19% at "medium risk", 33% at "low risk" of computerisation. Their findings are consistent both with LEVY and MURNANE's and with the polarisation observed by AUTOR: most of the high-risk occupations fall within the MR category: Office and administrative support, telephone operators are examples.

The literature following this approach is enormous. Perhaps it is worth highlighting McKINSEY's report (2016), that further refines the approach by dividing occupations into activities, and classifying these activities according to the LEVY and MURNANE criteria, coming to the conclusion that while between 45 and 60% of all activities could be automated, less than 5% of jobs are likely to be completely automated. The reason for this paradox is that automatable jobs are made of large parts of automatable activities, but most of them have non-automatable activities too. The conclusion is that digitalization will lead to a complete restructuring of tasks, workplaces and jobs throughout the economy, but that this process will take time.

The mainstream approach contains many other threads: questioning the implicit assumption that computers and robots will always be substitutes for human labour, some stress the fact that they can often be complements: man may work against the machine or with it; the same computer can be used to enhance the productivity of a worker (an expert decision system for a doctor) or to replace a professional (a screening device for a receptionist at a clinic). Here is a graph from the McKINSEY report that illustrates the kind of result that can be obtained:

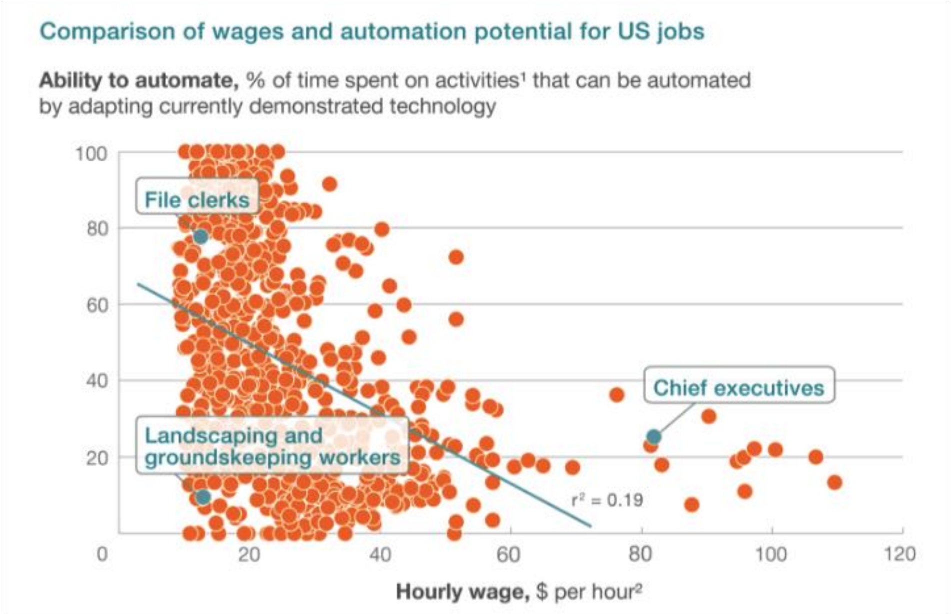


Fig.1: wages and automation potential, according to Mc KINSEY

The illustration is interesting: the reader sees that the graph conforms roughly to LEVY and MURNANE as well as to AUTHOR: the most vulnerable jobs are not the manual ones, but the low-to-middle-wage, routine ones (blue dot high up on the y-axis); jobs relatively unskilled but requiring physical presence are not at risk, but draw low pay, (blue dot near the origin) while CEOs (blue dot far to the right close to the x-axis) are both safe and highly paid, due to the uniquely human abilities they bring to the job. If you happen to be a file clerk, you would be grateful for any advice on how to slide down and to the right towards the blue dot "Chief executive". The graph itself does not say.

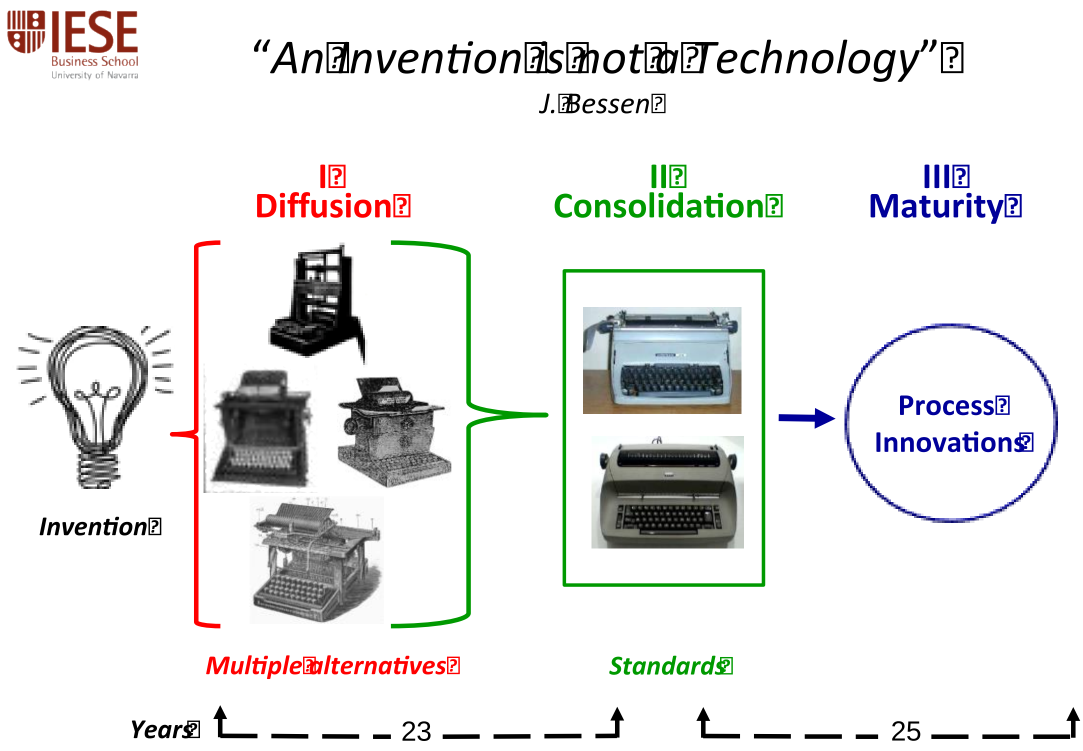
4. The time dimension: technology as knowledge

For all the many insights of the mainstream approach, it fails to take time into consideration: if jobs can be replaced, when will they be? Does digitalization happen all of a sudden, or does it take a long time? If it does take time, what happens to jobs and wages during the transition? The work of James BESSEN (2015) takes a completely different approach, based on the history of technologies, to address these questions.

Imagine a typewriter (if you are less than 50, you probably have never owned one). It may be an IBM Selectric, with its ball of characters in the middle of a space, from which it darts to the paper when you press a touch. Launched in July 1961, it looks like the acme of modernity; yet its principle, the writing ball, is the same as that of the Danish design that Nietzsche had delivered to his home in…1882! How many things have happened since! At the beginning, typewriters had very different designs and operated on different principles; people began to use them, but cautiously: no big paper-pushing firm –a shipping firm, a bank- made a massive investment in those devices, since there were many brands, many designs competing with each other, and no one knew who would win over the others[4]; for instance, each brand had its own keyboard, so being proficient with one machine did little to make one proficient on another, except for unusually gifted operators; the first standard keyboard, the Qwerty, designed in 1868, took a century to become almost universal, but some time before the number of designs had already decreased, and it was worthwhile both to establish a typewriting school and to attend it, since the market, both for pupils and for graduates, was there. The knowledge that surrounded that new invention, the typewriter, could be codified and taught by standard methods. As the industry matured, consolidation took place: to give an example, at some point, all Spanish police stations used the same model of typewriter: a grey-green Olivetti in which an American would have recognized immediately an Underwood: Underwood had been sold to Olivetti, only to disappear a few years later. Others were doing other things; still others –Remington-had gone back to their origins, the manufacture of arms. Then, of course, desktop computers took over: only the standard keyboard remained of an invention developed over more than a century. Typing was no longer a marketable skill, though stenography, a joint product of typewriting, still was. Secretaries did not vanish, their job changed: they took dictation for very important letters, but they also took care of their bosses' agenda, many under the apparently less demeaning title of assistant; true, an assistant helped more than one boss, but there were many more bosses (CN people), so the net effect of the rise and fall of the typewriter on the

[4] In a related field, it is a known fact that Mark Twain invested in a new linotype that proved to be the wrong design. Only a lecture tour enabled him to repair his damaged finances.

number of jobs was unclear, hard to trace, certainly not unambiguously negative.



Source: BESSEN

In trying to describe BESSEN's framework I have used the example of the typewriter because it is a familiar object to most of us. BESSEN has done a detailed study of the textile industry in Massachusetts and has a few other case stories, always under the same guiding principle: *an invention is not a technology, a technology is knowledge*. By following the tortuous path that knowledge follows as it grows and disseminates itself all through the economy a pattern emerges, which makes it possible to address the questions posed by the digital revolution. In doing so, one must take into account that no technologies are equal, every one has a different scope of application and is born in a different social and economic context. Some -the *lumpers*- will tend to stress the similarities, others -the *splitters*- will put the accent on the differences[5]. A general observation may be appropriate: the digital revolution has the potential of affecting many sectors at once, and the times are such that things seem to happen faster than before; so what was true for sewing-machines may not be true of self-driving cars.

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[5] I owe this invaluable distinction to the teachings of the late prof. Charles P. KINDLEBERGER.

How long does it take for a technology to mature? It depends, but the following table suggests that one generation is about right in many cases:

IESE Business School University of Navarra

4. TIME TO COMMERCIALIZATION

Invention	Year first patentable	Years to 1st commercialization	Years to Shakeout	Total
Ballpoint pen	1938	7	28	35
Transistor	1948	7	13	20
Gyrocompass	1852	56	55	111
Jet engine	1791	153	17	70
Radar	1904	31	17	48
Radio	1900	15	51	66
Television	1905	35	33	68
Average (19 inventions)		23	25	48

Source: BESSEN, cit., p. 39

So, if only because of how long it takes to establish itself, a technology cannot be described as an act of God, but rather as a process that can be acted upon.

What happens to the number of jobs? That depends, of course, on the time frame chosen (remember the long-viewers of #1: in the long run, all is well). In the short run, some jobs certainly disappear, but not necessarily in the areas invaded by computers: on the contrary, labour demand tends to be strong precisely in those areas where computers are being employed in greater numbers. There is at least one economic reason for this: as computers (or robots) replace people because of higher productivity, they allow prices of the product to fall, hence raising the demand for it…and hence the demand for workers and/or their wages. This apparent paradox highlights the possibilities of cooperative computerization: computers working with people rather than replacing them. Besides, the disappearance of jobs need not entail that of workers within the firm: some, if not most, are relocated to other tasks, or find employment in similar activities. In a normal business climate, it is difficult to ascertain the sign of the net effect of an innovation on employment. Of course, in a recession the process will lose much of its smoothness.

What about wages? These will depend, not only on the business climate (the demand for the final product) but also on the supply and demand of the skills required by the new technology, and here an interesting pattern emerges: in the initial phase (diffusion), when everything is in flux, training can be acquired only on the job; and, since the designs are so many and so different, only very smart people are capable of transferring the knowledge gained on one machine onto another one. Those people will be at a premium on the (very small) market, and a gap will open between their wages and those of common workers. As the technology solidifies and knowledge can be codified and taught by standard methods, the required knowledge will be more abundant, unexpected situations will become rarer, the premium on creativity will fall and, since the wage of common workers will have risen (remember, they are now more productive), the wage gap will close. Unusually smart people will leave the industry and go somewhere else. This is a very important insight, since it will guide our policy choice in a crucial matter, education, of which more in a moment.

The reader may wish to use BESSEN’s framework to think about the computer revolution, or some segment of it: how far are we in the self-driven car business? Do the waves of acquisitions in the software and network segments signal the beginning of a phase of consolidation, or is it rather a question of stifling potential competition? This level of discussion is more fun, and probably more enriching, than trying to calculate the probability of your being without a job in an indeterminate future.

5. Policy

None of the above paints an end-of-the world picture, but neither does it dispel our worries. We are left with the impression that something must be done about this technology business. But what exactly? An answer is not available; we shall just attempt to guide the reader first through some general policies that can be applied to technology; then through the universal medicine recommended by all, education, to reach at last an important, if not exactly novel conclusion.

Inequality

Few people have contributed as much as Sir Anthony ATKINSON to the study of inequality. Insofar as technological change is often considered as a main source of income inequality in our economies, ATKINSON has come forth with some recommendations which correspond to the standard approach based on economic incentives. [6] His proposals are based on a fact beyond dispute: *technology, being developed by people, is endogenous to society at large*. The state, in particular, plays a large role in influencing its development: it funds research and pays for many of its products. In fact it is hard to find a technology that does not have at its origins one or various Government projects (more often than not in the military). Consequently, the Government can, if it wants to, exert a decisive influence on the direction of technical change. It would do so, for example, by trying to assess the influence of any given project on job creation, and adding this criterion to its toolbox of cost-benefit analysis. This line of action by the State, however, is likely to conflict with other goals deemed superior, or more urgent, and the effect of this recommendation upon public procurement may not be perceptible. Furthermore, making the employer internalize the effects of labour-saving innovations is tantamount to impose higher severance costs. If so, it raises the cost of hiring.

Education: A Warning

What else can be done to make people better equipped to face technological change? The universal answer is always the same: education. Of course. But education of what sort? The conventional answer, quoting the "knowledge economy" is almost always the same: higher education, particularly in technology and the sciences. Such an answer, however, is likely to lead to great mismatches with the attending misallocation of resources and personal frustrations. The following table, drawn from BESSEN' work, may serve as a call for attention:

[6] ATKINSON (2015) and, of course, his *Inequality* (2016), pp. 115 ff.

Skill requirements compared with actual levels in the US

Required Educational Level			Current Population	
	2012 (actual)	2022 (projected)	L. force (actual)	Aged 25-34
High school or less	66%	65%	35%	33%
Some post-secondary	11%	12%	30%	29%
Bachelor's degree	18%	18%	23%	27%
Masters or higher	4%	5%	13%	11%

Source: BESSEN, J.: Learning by Doing (2015), p.143

The table shows the sort of skills industry seems to need in the near future and the likely supply coming out of educational institutions. Nowhere can we see that the economy demands, or needs, a surge of college graduates, while too few people may be coming out of high schools (including vocational schools). Let it be pointed out here that this is in no way inconsistent with the persistence of a wage premium for college graduates. It is still true that a college-degree job will pay more than a high-school one…if you can get it.[7]

A technology is knowledge, and knowledge manifests itself at least in part in skills. But the kind of knowledge and the required skills vary through the unfolding of a technology, following the pattern just outlined. Education is 'required' by technology in two different senses: first, as true technological requirements, specific vocational skills: weaver, typist, programmer. Second, knowledge is also used as s screening device, a proxy for the general ability to learn. When a technology is at an early stage of development, when technological alternatives are many and diverse with no clear winner, the required knowledge can only be taught on the job: textbooks do not exist, classroom teaching is not

[7] The next paragraph follows closely BESSEN's book, Chs. 8-10.

possible, no one has an interest in making big investments in either teaching or learning any one of the many technological alternatives present. In this phase a general ability to learn, and hence to face unexpected situations, is most important, and 'knowledge' of the second sort is in high demand. Now on the one hand, such people are relatively rare, so they will command a premium in the very small labour market for them. On the other hand, the ability to learn is itself fostered by learning, so knowledge in this second sense is fostered by general education: this is the reason why the employers at the Lowell textile mills required their employees to know the three R's, Reading, 'Riting and 'Rithmetic.

But as a technology matures, it builds knowledge in the first sense, as a set of specific technical requirements that can be taught at the level of vocational training. As this stage is reached, the relative scarcity of very creative people, and hence, by approximation, of college-educated people, tends to disappear: there is a downward compression of wages in the industry. With reference to the IT industry, BESSEN notes that not all users of IT need an advanced degree; that one-third of IT workers lack a college degree, and that, while it is true that the college premium is high and growing, the demand concentrates on experienced college graduates. Those among them which are no good at learning on the job may find themselves in low-skill jobs.

BESSEN also draws on an example in the health-care industry, where the development of ambulatory surgery has led to a fall in the demand for registered nurses, whose training enables them to perform tasks not needed in doctor's clinics; the job is taken by licensed practical nurses, with less training, skills easier to acquire, but no wage premium. The work of BESSEN indicates that schooling is, without doubt, necessary, but that it has to be carefully planned, and that the pressure towards funding higher education at the expense of the rest may be a serious mistake: we may end up with an excess of highly trained, but perhaps not first-rate college graduates loath to take on the jobs that await them it on lower skill levels.

As a last example of the possibility of creating large mismatches between the supply and demand for skills, the following table suggests that most jobs will be created in activities that do not require a college degree:

Is Education the Answer?

WHO WILL BE HIRING IN 2018?

Ten Occupations with the Greatest Growth Increase 2008–2018

(US Total Projected Job Growth: 10.0%)

Food Preparation and Servers	3,149,426	14.6%
Customer Service Representatives	2,736,825	17.7%
Long-Haul Truck Drivers	1,845,612	13.0%
Nursing Aides and Orderlies	1,699,615	18.8%
Receptionists	1,302,100	15.2%
Security Guards	1,214,882	14.2%
Construction Laborers	1,180,571	20.5%
Landscapers and Groundskeepers	1,128,803	18.0%
Home Health Aides	1,058,041	50.0%
Licensed Practical Nurses	825,651	20.7%

Sources: Bureau of Labor Statistics and Help Wanted

Roles of the State

The State can both influence the direction of technical progress, protect prospective losers in an efficient way and make access to the required knowledge less difficult. Here are some possibilities out of a potentially long list:

1. From labour's point of view, the transition to a new generation of technology has become more difficult due in part to the shifting of public funds away from community colleges and vocational school towards higher-education institutions, just when these more specialized skills will be most in demand. Educational policies should reconsider this shift.

2. The growth of occupational licensing (the number of occupations for which a state license is needed has gone from 5% to 29% of all occupations in the US in recent years) restricts training and jobs for middle-skilled workers and generates rents for incumbents (note that the

role of rents in generating income inequality is becoming increasingly visible. Licensing should be granted only when needed to protect prospective consumers without adequate information.

3. As already said, the State has helped technical progress through public procurement, especially in fields related to defense. However, today funds tend to be allocated to large conglomerates, and secrecy and security concerns prevent independent or small innovators to participate in the generation of knowledge.

4. Abusive patent litigation tends to stifle innovation by making it an extremely uncertain venture (patent trolls, excessive patent activity).

5. Protecting good manufacturing jobs by subsidies or tariffs is probably inefficient and often useless; re-training is more effective.

Recommendations to business people

We have outlined possible roles for the State, but one should not forget that the primary role in managing the digital revolution belongs to business managers. So it may be useful to start a debate that will no doubt enrich the list below, perhaps by making it shorter:

1. Don't be obsessed by the prospect of massive layoffs. Jobs change their content, take on additional tasks, very few jobs disappear altogether. Don't panic, especially in front of your employees. Dr. Bessen says the only job he's seen disappear completely is that of elevator operator.

2. Don't be afraid that digitalizing an activity will result in less need for people. First, computers often work with, not against, people. This is why activities where new jobs are created are often those which are more computer-intensive. Classic example: the appearance of ATMs has not reduced the number of bank tellers.

3. It may happen that higher productivity resulting from digitalization allows you to reduce the price of your product, and higher sales may allow you to keep employment (if the business climate is good).

4. Take an active role in training your personnel: the times where you could wait to see what came out from

learning institutions may be over. This is especially true, of course, in early stages of a technology, when training on the job is most important.

5. Watch carefully developments in the digital industry (you may need outside help for that). Remember the skills needed in each phase of the process are different.

6. Make internal flexibility a must. This will be easy if your employees see that adequate training is provided on your side.

7. Make your workforce participate actively in monitoring the digital environment. They may see things you don't, and you will gain their confidence and keep a good morale.

8. Remember the general pattern a new technology follows. The first-mover advantage is extremely elusive in the first phases. Don't jump on the latest innovation, let others do that first.

Is it possible to draw conclusions from all this? Just one: technological change is everybody's business, since technology is done by us and paid for by us; if all of us cannot enjoy its advantages, all suffer its mistakes. One should follow with diligence its progress and have the courage to make oneself heard whenever it takes a wrong turn. Mankind ought to be able to harness technological progress and not be harnessed by it.

ADDENDUM: Safety in the workplace[8]

New occupations are created and destroyed all the time, which is why the question 'How many of today's jobs will still be around in twenty years?' is a very imperfect way of addressing the issues raised by the digital revolution. Sometimes, new occupations are born as a result of social concerns or regulatory pressure, not as the product of a new technology. As concerns the pattern of skills and wages, however, the process is similar to that followed by the spread of a technology. This is the case of safety at work.

[8] I owe this insight to Messrs. Puigferrat and Galopa of COPCISA, a Spanish construction company.

Men at lunch, New York City, 1929

This well-known picture suggests that safety in the workplace cannot have been the most pressing concern of construction companies one century ago. The International Labour Organization (ILO) had been created in 1919 with the Treaty of Versailles, but it had no legislative powers and could only make recommendations; hence adopting safety measures was left to the initiative of individual companies, sometimes at that of individual construction sites. In the most safety-conscious firms, civil engineers in charge of operations were charged with the task of studying tools, equipment and procedures that could improve safety; their knowledge of the many aspects of construction work enabled them to devise solutions for a great variety of problems. Slowly a set of best practices was created, some standards adopted –helmets, gloves, goggles, harnesses- and, many years later, as a result of social and legislative pressure, union demands the development of accident insurance, a uniform set of protocols has become standard in the industry the world over; the picture below can be seen at the entrance of most construction sites.

At the entrance of a construction site, 2017

As standardization proceeded, knowledge could be codified and taught; one century later, safety at work was in the curriculum of vocational training programs; degrees in safety at work were offered in some colleges. Construction companies hired cheaper specialists and left civil engineers free for higher tasks: their ability to face unexpected situations was no longer need there. No jobs had been destroyed, but the skills demanded and the wages paid had followed a pattern similar to that observed during the adoption of a new technology.

Disclaimer

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